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RELATIONSHIP BETWEEN RICE PRODUCTION, FISHERIES PRODUCTION AND GROSS DOMESTIC PRODUCT (GDP) IN BANGLADESH: Co integrating Regression Analysis (1971-2017)

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Abstract: The aim of this paper is to investigate the relationship between rice production, fisheries production and gross domestic product (GDP) in Bangladesh. Agricultural sector and fishery sector play an important role in Bangladeshi economy. These sectors have great contribution to increase gross domestic production (GDP), create employment opportunities and ensure food security of Bangladesh.

Annual time series data used for the study over the period of 1971 to 2017 in Bangladesh. Different kinds of econometric techniques applied to conduct the study, namely, augment Dickey-Fuller (ADF) test, Phillips-Perron (PP) test, Johansen co integration test, fully-modified least squares (FMOLS) method and dynamic least squares (DOLS) method. To justify the model some residual diagnostic tests were employed.

The results of the study indicated that rice production has a positive and significant impact on gross domestic product (GDP) in Bangladesh. On the other hand, although fisheries production has a positive effect on gross domestic product (GDP), this impact is not significant at 5 or 10 percent level of significance.

Since the contribution of fisheries production is not significant to gross domestic product (GDP) the government should create more facilities, and provide more subsidies, new funding schemes and training programs to the fish farmers. Furthermore, the government should increase government expenditure in the fisheries sector and implement more modern technologies to enhance the fish production of Bangladesh. Last but not the least; the government should be concerned about some climate changing and man-made factors which are also the causes for reduction of fish diversity and production in Bangladesh.

Keywords: Gross domestic product. Rice production.Fisheries production.Co integration .FMOLS.DOLS. Bangladesh.

1. INTRODUCTION

Bangladesh is an overpopulated, agrarian and labor surplus country in the world. Most of the people (about 70 percent) in Bangladesh live in rural areas. There are

three main economic sectors in our country, namely, agriculture, industry and services. Among the three sectors, agricultural sector is a very crucial sector for rural development, and there is a direct relationship between the rural development and the national economic development. According to a survey of 57600 households, out of 47019071employed people, 24392878 are employed in the agricultural sector (Report on agriculture and rural statistics, 2018). Another report represented that out of 2748004 households, 63.11 percent are farm households (Report on agriculture and rural statistics, 2018). In spite of continued loss of cultivable land areas, agricultural sector (including fisheries) revealed noticeable progress in Bangladesh. The increase of food grain for the last four decades was remarkable, and Bangladesh government has given highest priority to the agricultural sector (Barkat-e-Khuda, 2019). According to Bangladesh economic review (2018) the contribution of the agricultural sector to gross domestic product (GDP) is 14.23 percent and about 40.62 percent labor force is engaged in the agricultural sector.Agricultural sector consists of four sub-sectors- crops, livestock, forestry and fisheries. Rice and fish are the staple food and national diet of Bangladesh. There is a proverb in Bangladesh; it is "MaacheBhateBangli". It means fish and rice makes a Bangladeshi (Hossain, 2014). Rice is thelargest growing, chief and inelastic crop for Bangladeshi people. Rice production plays an important role in our economy. It generates employment opportunities for both men and women in rural area. Rice production alleviates rural poverty, help to achieve self-sufficiency in food production and exhort sustainable economic development. It contributes about 70 percent to agricultural gross domestic product (AGDP) and it has one-sixth share of national income (Murshid&Yunus, 2016). In Bangladesh about 13 million families grow rice. Rice production provides 48 percent rural employment about two-third of total calorie supply and about one-half of the total protein intakes of an average person Bangladesh (Bangladesh Rice Knowledge Bank). Rice meets the demand of carbohydrate, food security, and nutrition. There are three rice-growing seasons in Bangladesh- Aus, Aman and Boro. The maximum amount of rice grows in Boro season. Moreover, climate change negatively affects the rice production. Due to the flood, cyclone, salinity, drought, extreme temperature stresses we lose a significant amount of rice every year. On the other hand, the fisheries sector also has great contribution to the economic and socioeconomic development of Bangladesh. There is an adage in our country; it is "MaacherPonaDesherSona". It means fingerlings are gold of Bangladesh. Bangladesh is one of the leading fish producing countries in the world. A significant portion of our gross domestic product (GDP)also comes from fisheries sector. The contribution of the fisheries sector to gross domestic product (GDP) is 3.61 percent and to agricultural gross domestic product (AGDP) 24.41 percent. More than 11 percent of the total population is employed in the fisheries sector. Among the employers involved with the fisheries sector,10 percent are women and it is 1 percent of the total population.About 80

percent women workers work for fish producing plants and fish drying centers. Sixty percent (60 %) animal protein we get from the fisheries sector (Yearbook of fisheries statistics of Bangladesh, 2017-18, DoF 2013, Hossian *et al.* 2013).

Fisheries sector is also one of the most important foreign currency earning sectors in Bangladesh and it is in third position for earning foreign currency (Hossain, 2014). Bangladesh earned TK. 4,309.9 crore in FY 2017- 18 by exporting fish and fish products, while in FY 2016-17 the amount was TK. 4,287.64 crore (Bangladesh economic review, 2018). Among fish species Shrimp and Prawn are the major export fish items in Bangladesh. 2.5 percent of global production of Shrimp produces in Bangladesh, and fisheries and aquaculture sector is the second largest export sector of our country. Prawn farming played an important role to improve the livelihoods of the coastal poor people. The rapid progress of Prawn farms in the southwest region of Bangladesh during the 1990s is mentioned as a blue revaluation by Ahmed *et al.* (2010). The EU (European Union) and USA are the major buyers of Shrimp and Prawn from Bangladesh. Fisheries sector is the second largest employer sector in rural area (Hossain, 2014). Nowadays young and educated generations are very enthusiastic for fish growing. The remainder of this article is arranged as follows: in the literature review section I discussed about some research papers which are related to my research topic and a description of different key research approaches are illustrated. In the next part I discussed the methodology and data sources. Then in the model specification section, this paper introduces an empirical model to investigate the relationship of rice production and fisheries production on gross domestic product (GDP) in Bangladesh. After that, this paper displayed and described the model results. Finally, discussion, and conclusion sections were included in the paper.

2. REVIEW OF LITERATURE

Rehman *et al.* (2017) conducted a study in Pakistan to investigate the relationship between the rice output, its production area, water availability, and agricultural gross domestic product for the period of 1970-2015. Annual time series data were used to conduct the study. Augmented Dickey-Fuller test, Johansen co integration test and ordinary least square (OLS) method were employed to complete the study. The findings of the study revealed that there is a long-run relationship between the dependent variable and independent variables. Moreover, ordinary least square (OLS) method suggested that rice output and cultivated area has a significant and positive impact on agricultural gross domestic product. On the other hand, water availability has negative impact on agricultural gross domestic product (AGDP). Rehman&Jingdong (2017) examined a study in China to explain and explore the relationship between major food crops and their relationship with agricultural gross domestic product (AGDP) from 1980 to 2015. Annual time series data were used for the study. Different kinds of econometric methods were applied to examine the

study, namely, augmented Dickey-Fuller test, Johansen co integration test and ordinary least squares (OLS) method. From their study, they found that the rice output has a negative and insignificant impact on agricultural gross domestic product (AGDP), while wheat, cotton, sugarcane, corn, and tubers have a positive and significant impact. Rehman *et al.* (2015) investigated a study to show the relationship between agricultural gross domestic product (AGD) and the production of some major crops in Pakistan for the period of 1950-2015. Annual time series data were used for the study. Augmented Dickey-Fuller (ADF) test, Johansen's co integration test and ordinary least square (OLS) method were applied for the study. The outcomes of the study indicated that production of rice, wheat, and cotton has a positive and significant relationship with an agricultural gross domestic product (AGDP). On the other hand, sugarcane has a negative and insignificant impact on agricultural gross domestic product (AGDP) of Pakistan. Rehman *et al.* (2019) inquired a study to examine and pursue the relationship between aquaculture and capture fisheries production and economic growth in Pakistan from 1970 to 2015. Their study was based on annual time series data. To check the dynamic causality between the variables an autoregressive distributed lag (ARDL) bounds testing approach was applied. The findings of the study suggested that aquaculture and capture fisheries production have had a positive effect on economic growth. Rotowa *et al.* (2019) operated a study to investigate the contribution of fisheries, agriculture and forestry to economic growth in Nigeria over the period of 1981 to 2016. The findings of the study revealed that agriculture, fisheries and forestry productivity had a positive effect on Nigerian economic growth. But the government has less attention on these crucial sectors. Fish production creates employment opportunities in Nigeria. Gurung (2016) examined a study to illustrate the role and potential of inland fisheries and aquaculture for food nutrition security in Nepal. For the study, he/she collected the information from different kinds of secondary sources to estimate per capita fish consumption. His / Her calculated results depict that per capita fish consumption has raised 125 g (1975) to 2060 g (2013). He / She also explained that the aquaculture and open-water capture fishery contributes about 2 percent of agricultural GDP. Although this portion is very small, promising having a faster 8 to 9 percent annual growth rate in Nepal. According to his / her analysis, among the five development regions in Nepal, the Central Development Region was at the top of fish production. On the other hand, Far-Western Development Region was at the bottom for fish production in Nepal.

From the above literature review, I can clearly opine that most of the researchers investigated the impacts of fisheries and rice production on agricultural gross domestic product (AGDP). Since Bangladesh is an agricultural dependable country, and rice and fisheries sectors have great contribution to our economy I think that we should discuss the effect of rice and fisheries production on gross domestic product (GDP) in Bangladesh. Besides, very few studies have been conducted to

investigate the relationship between rice production, fisheries production and gross domestic product (GDP) in Bangladesh, and researchers in my literature review discussed the effect of rice production and fisheries production on agricultural gross domestic production (AGDP) separately. But in this paper I have included the two variables (rice production, fisheries production) in a single model to show their relationship on gross domestic product (GDP). Finally, the application of FMOLS and DOLS and their econometric interpretations make my research paper differs from other researchers.

3. DATA AND METHODOLOGY

Table 1

Abbreviation	*Definition*	*Source*
GDP	Gross domestic product (current US$), (1971-2017)	World Bank national accounts data, and OECD National Accounts data files.
RICE	Rice production (1000 metric tons), (1971-2017)	United States department of agriculture.
FISHERIES	Total fisheries production (metric tons), (1971-2017)	Food and Agriculture Organization, Year book of Fisheries Statistics of Bangladesh 2017-18

For any kind of econometric time series analysis, we should first check the stationary of the variables. To avoid spurious regression stationary time series are very important (Gujarati, 2003). Most of the cases economic variables are non-stationary at level (Andrei & Andrei, 2015).

For this study here I used augmented Dickey-Fuller (ADF) test and Phillips-Perron test to identify the stationary of the variables. If the error term u_t is correlated, we can apply augmented Dickey-Fuller (ADF) test to overcome the problem.

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t$$

ε_t is a pure white noise error term and where $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2}), \Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$, etc. (Gujarat, 2003). Augmented Dickey-Fuller (ADF) test considers the serial correlation problem by adding lagged difference terms. But Philllip-Perron test uses nonparametric statistical methods to avoid the serial correlation problem without adding lagged difference terms (Gujarati, 2003). To check the stationary of the variables I also applied Phillips-Perron test. The unrestricted VAR model was used to determine the optimum lag

length. The Johansen co integration test was employed to determine the co integrating vector (s) and investigate the number (s) of co integrating equation exist between gross domestic product (GDP) and independent variables (rice production, total fisheries production). Phillips and Hansen (1990) first introduced the fully-modified least square method (FMOLS) and this method has great application to calculate the long-run elasticity between the dependent and independent variable(s). It takes the semi-parametric approach to estimate the long-run parameters (Adom, *et al.* 2015). This method is useful for small sample size data and provides consistent parameters. Besides, it overcomes many problems, namely, serial correlation, endogeneity, omitted variable bias and measurement errors, etc. This method is also applicable for the heterogeneity in the long-run parameters (Kalim & Shahbaz, 2008; Fereidouni *et al.* 2014). If the variables are co integrated at their first difference, then we can apply fully-modified least squares (FMOLS) method. To calculate the long-run elasticity between gross domestic product (GDP) and independent variables (rice production, total fisheries production) dynamic least squares (DOLS) method was also employed. Stock and Watson (1993) first introduced the method. Including leads and lags DOLS deals with simultaneous bias and it is also very effective for small sample size data (Kurozumi & Hayakawa, 2009). If the variables are co integrated then we can apply DOLS method to estimate the long-run elasticity between the variables. Employing this technique we get unbiased estimators and these estimators are asymptotically efficient. Moreover, DOLS overcomes the problem of serial correlation, endogeneity etc. Besides, it ensures the normal distribution of residuals (Herzer *et al.* 2006). Finally, some residual diagnostic tests (normality test, serial correlation test) were applied to justify the model.

4. MODEL SPECIFICATION

In order to analyze the relationship between gross domestic product (GDP) and independent variables (rice production, fisheries production), the following model estimated as follows:

$$Y = AX^{\lambda_1}{}_1 X^{\lambda_2}{}_2 \tag{1}$$

Taking the natural logarithm of the equation (1) and considering two independent variables, the equation (1) is converted to the following form:

$$LNY = \lambda_0 + \lambda_1 LNX_1 + \lambda_2 LNX_2 + e_t \tag{2}$$

Here, λ_0 = Natural logarithm of A=Intercept of the equation; LNY = Natural logarithm of gross domestic product (GDP); LNX_1 = Natural logarithm of rice production; LNX_2 = Natural logarithm of total fisheries production; e_t = error term.

So, we can write equation (2) as follows:

$$LNGDP = \lambda_0 + \lambda_1 LN(RICE) + \lambda_2 LN(FISHERIES) + e_t \quad (3)$$

5. RESULTS ANALYSIS

5.1. Unit Root Test

In this paper, I applied augmented Dickey-Fuller (ADF) test and Phillips-Peron (PP) test to identify the unit root of the variables. The null and alternative hypotheses for unit root test are as follows:

$\mathbf{H_0}$: LNGDP/LNRICE/LNFISHERIES has a unit root.

$\mathbf{H_1}$: LNGDP/LNRICE/LNFISHERIES has not a unit root.

As I observe from the table 2 and table 3 that LNGDP, LNRICE and LNFISHERIES are non-stationary at their level form, whilst all the variable become stationary at their first difference, as shown by the values of augmented Dickey-Fuller test statistics and Phillips-Peron test statistics. Here, the null hypothesis is not rejected by 1%, 5%, and 10% level of significances for the first difference of the variables, and the integrated order of the variables is I (1). Since LNGDP, LNRICE and LNFISHERIES have integrated order of one; i. e I (1) hence I can run Johansen co integration test to determine the existence of co integrated equation(s) in the model. The results of the ADF test and PP test are provided in table 2 and 3 respectively.

Table 2
Augmented Dickey-Fuller test

Variables	*Test critical values t-statistics*			*At level*		*At first difference*	
	1%	*5%*	*10%*	*t-statistic*	*Prob.*	*t-statistic*	*Prob.*
LNGDP	-3.6210	-2.9434	-2.6102	0.036	0.957	-7.167	0.000
LNRICE				-1.201	0.665	-9.313	0.000
LNFISHERIES				1.698	0.999	-4.763	0.000

Table 3
Phillips-Perron test

Variables	*Test critical values t-statistics*			*At level*		*At first difference*	
	1%	*5%*	*10%*	*Adj.t-stat*	*Prob.*	*Adj.t-stat*	*Prob.*
LNGDP	-3.581	-2.926	-2.601	1.164	0.997	-12.713	0.000
LNRICE				-1.279	0.631	-9.261	0.000
LNFISHERIES				1.734	0.999	-4.935	0.000

5.2. VAR lag length selection

The Johansen co integration test is very sensitive to lag length. So, selectingan optimum lag length is very crucial before applying Johansen co integration test. There are many lag selection criterion. Table 4 depicts that the optimum lag length is 3, which is supported by all the lag selection criterion. The results of the unrestricted VAR model for lag length identification are presented in table 4.

Table 4
VAR lag order selection criteria

Lag	*LogL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	31.57871	NA	5.31e-05	-1.329242	-1.206368	-1.283930
1	184.3434	277.1080	6.64e-08	-8.015972	-7.524474	-7.834723
2	210.4726	43.75127	3.01e-08	-8.812680	-7.952559	-8.495494
3	228.7096	27.99166*	2.00e-08*	-9.24231*	-8.01356*	-8.789185*
4	236.4990	10.86889	2.18e-08	-9.185999	-7.588632	-8.596940

N: B: *indicates lag order selected by criterion, LR: sequential modified LR test statistic (each test at 5 percent level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion.

5.3. Co integration Test

Since LNGDP, LNRICE and LNFISHERIES have integrated order of one, hence I can run Johansen co integration test. I operated the test where LNGDP is the dependent variable and LNRICE, LNFISHERIES are the explanatory variables. The null and alternative hypotheses are as follows:

$\mathbf{H_0}$: Co integration equation is not found between the time series variables

$\mathbf{H_1}$: Co integration equation is found between the time series variables

As I see from the table 5, according to trace test results there is a one co integrating equation in the model at the 5 percent level of significance. For ‘none’ I can reject the null hypothesis, because the level of significance (5 percent) is greater than the probability value (0.0013). Moreover, trace statistics (41.88415) is greater than 29.79707 (at 0.05 critical values). Same conclusion, I also can draw from the Max-Eigen value test. It is evident from table 5 that for ‘none’ level of significance (at 5 percent) is greater than the probability value (0.0005), and the value of Max-Eigen value test statistics (33.70143) is greater than 21.13162 (at 0.05 critical values). As a result, I can reject the null hypothesis of no co integration equation is found between the time series variables. Here, Max-Eigen value test also represents that there exists a long-run relationship between gross domestic product (GDP) and independent variables (rice production, fisheries production), and the model bears one co integrated vector or one error term. The results of the Johansen co integration test are represented in table 5.

Table 5
Johansen co integration test

Hypothesizes No. of CE(s)	*Eigen value*	*Trace statistic*	*0.05 critical value*	*Prob.***	*Max-Eigen statistics*	*0.05 critical value*	*Prob.***
None*	0.543312	41.88415	29.79707	0.0013	33.70143	21.13162	0.0005
At most 1	0.166507	8.182717	15.49471	0.4461	7.831604	14.26460	0.3961
At most 2	0.008132	0.351113	3.841466	0.5535	0.35111	3.841466	0.5535

Trace test and Max-Eigen value test indicates 1 co integrating equation(s) at the 0.05 level.
*Denotes rejection of the hypothesis at the 0.05 level.
** MacKinnon-Haug-Michelis (1999) p-values

5.4. Fully-Modified Least Squares (FMOLS)

To examine the long-run elasticity between the rice productions, fisheries production and gross domestic product (GDP) in Bangladesh the fully-modified least squares (FMOLS) method was applied. The results of the FMOLS analysis are reported in table 6. From the FMOLS results, the value of goodness of fit (R^2) is 0.9418 or 94.18% and the adjusted R^2 is 0.9391 or 93.91%. This represents about 93% of total variation in gross domestic product (GDP) is explained by the independent variables (rice production, fisheries production). An analysis of the FMOLS results depicts that the coefficient of the production of rice is highly significant at 1, 5 and 10 percent level of significances, which means that there is a strong positive significant relationship between rice production and gross domestic product (GDP) in Bangladesh. This implies that 1 percent rise in the rice production showed a rise in gross domestic product (GDP) of 2.08 percent. The results further represent that there is a positive relationship between the fisheries production and gross domestic product (GDP), but this is not significant at 1, 5 and 10 percent level of significances. Whatever, I can say that every 1 percent increase in fisheries production leads to a 0.1494 percent increase in gross domestic product (GDP). Furthermore, analysis of the residual diagnostic test results of the model shows that the residuals are normally distributed and there is no serial correlation presence in the model. The values of the Jarque-Bera statistic and p-value are respectively 0.5335 and 0.7658. Correlogram test confirmed that there is no serial correlation in the model.

Table 6
Dependent variable: LNGDP
Method: Fully Modified Least Squares (FMOLS)

Variables	*Coefficient*	*Std. Error*	*t-statistic*	*Prob.*
LNRICE	2.082781	0.449764	4.63082	0.0000
LNFISHERIES	0.149411	0.271241	0.550842	0.5846
Constant	1.714639	1.300907	1.318033	0.1945
R^2 = 0.9418,	Adj. R^2 = 0.9391,		S.E of regression = 0.2278	

5.5. Dynamic Least Squares (DOLS)

To analyze the long-run elasticity between the rice productions, fisheries production and gross domestic product (GDP) in Bangladesh the dynamic least squares (DOLS) method was also employed. The results of the DOLS analysis are illustrated in table 7 and I got approximately the same results by applying DOLS method. From the DOLS results, the value of goodness of fit (R^2) is 0.9595 or 95.95 % and the adjusted R^2 is 0.9503 or 95.03 %. This represents about 95 % of total change in gross domestic product (GDP) is explained by the independent variables (rice production, fisheries production). The empirical results clearly expose that there is a strong significant positive relationship between rice production and gross domestic product (GDP) in Bangladesh. This means that 1 percent increase in rice production increased gross domestic product (GDP) by 1.89 percent. On the other hand, although there is a positive relationship between fisheries production and gross domestic product (GDP), it is not significant at 5 or 10 percent level of significance. Whatever, I can say that every 1 percent increase in fisheries production leads to a 0.2333 percent increase in gross domestic product (GDP). Finally the results of residual diagnostics tests provide that the residuals are normally distributed (Jarque-Bera statistic: 0.4213, p-value: 0.8100), and correlogram test ensured that there is no serial correlation presence in the model.

Table 7
Dependent variable: LNGDP
Method: Dynamic Least Squares (DOLS)

Variables	*Coefficient*	*Std. Error*	*t-statistic*	*Prob.*
LNRICE	1.894792	0.680446	2.784631	0.0086
LNFISHERIES	0.233302	0.382134	0.610525	0.5455
Constant	2.408974	1.869417	1.288623	0.2050
R^2 = 0.9595,	Adj. R^2= 0.9503,		S.E of regression = 0.1910	

6. DISCUSSION

From the above analysis I have seen that the impact of rice production on gross domestic product (GDP) is positive and significant (Rehman *et al.* 2017). Implementing nuclear technology and bio-technology Bangladesh government has been supplied saline tolerant and short duration crop variety to farmers in Bangladesh. Nowadays, in the coastal areas (southern region) of Bangladesh most of the farmers cultivate saline tolerant rice. The government also has been taken steps to provide more subsidies on agricultural sector, already increased the availability of irrigation instrument, implemented varies programs to increase rice production, eradicated water logging problem from haor areas (Bangladesh economic review, 2018). Besides, quality seed is another crucial input to increase rice production. In Bangladesh the government, NGOs and different seed producing

organizations are providing high quality seed distribution activities of hybrid rice to cultivators. Certified seeds of rice are also being supplied at 75 contract growers' zones.15-20 percent extra yield we get only for quality seed (Bangladesh economic review, 2018). Furthermore, 9 horticulture development centers and 14 agro service centers of Bangladesh Agricultural Development Corporation (BADC) are producing and distributing the seed, seedlings and other planting materials throughout the country. To increase the production of rice effective use of chemical fertilizer is also an important issue. Bangladesh government arranged various training programs for farmers to utilize chemical fertilizer effectively. In FY 2017-18 total 509345 metric tonnes chemical fertilizer was effectively utilized in Bangladesh (Bangladesh economic review, 2018). Government has been implementing Rubber Dam project to utilize surface water more effectively. Besides, removal of water logged, re-excavation of canals, embankment, underground irrigation channel, construction of Jhiribadh in hilly areas are being processed. The government also formulated hassle free and easier agricultural and rural credit disbursement policy and programs for farmers. In FY 2017-18 the government disbursed total TK. 21393.55 crore as agricultural and rural credit (Bangladesh economic review, 2018). Bangladesh government is working tirelessly and sincerely for bumper production of rice in Bangladesh. The government allocated Tk. 65447 crore to farmers since 2009 (The Independent, 2018). From 1972-73 to 2016-17 the average growth rate of food grains was 2.89 percent and this growth rate was respectable (Taslim, 2018). The government of Bangladesh has attempted to stabilize rice prices through open market sales since 2004. According to Bangladesh Pratidin Bangladesh is going to achieve third place in rice production in the world. Favorable weather condition, high quality seeds, higher acreage are the important factors for bumper rice production in Bangladesh (Zaman, 2019). If we go back in history to the early seventies, Bangladesh faced with many natural disasters and these natural disasters destroyed large areas of paddy field. But nowadays these disasters cannot hamper production of rice like in the past due to the implementation of modern technology in agriculture, high quality yielding seeds, and top quality fertilizer. So, the rice production is positively and significantly affecting the gross domestic product (GDP) of Bangladesh. From results analysis I have also found that the impact of fish production on gross domestic product (GDP) is positive (Rehman *et al.* 2019). But the impact is not significant at 5 or 10 percent level of significance. This insignificant impact could be the results of unfavorable climatic conditions and fluctuations of market prices of fish and fish related product in domestic and international markets. Besides, there are many man-made causes for this insignificant impact. Reductions of water flow, polluted river water, high level of salinity in river water are the major sources of riverine fisheries depletion. Due to industrial development the uses of ground and surface water have been increased more than the past. As a result, extreme pressure has been transferred on fisheries

sector, resulting in a significant reduction in fish species and population. Furthermore, excess rainfall, cyclone, drought, poor water quality, less availability of aquaculture, reduction of optimum depth of wetland, raised turbidity of water and excessive siltation are also the crucial environmental factors for reduction in fish production and diversity. Moreover, over-fishing by using illegal and banned fishing crafts and gears, Jatka fishing (catching young hilsa), catching mother fish, fishing during the ban period, poor fishing infrastructure, lack of knowledge among farmers, using fertilizer and pesticide, and poor resources management arealso the significant reasons for declining fish production of Bangladesh. Table 8 represents the number of the disappeared fish species and number of fish species that production has reduced through the six districts in Bangladesh.

Table 8

Districts	*Number of disappeared fishspecies*	*Number of fish species that production has reduced*
Rajshahi	31	43
Khulna	35	75
Dhaka	29	59
Barisal	34	102
Sylhet	27	57
Chittagong	28	58

Source: The Daily Star (July 20, 2016)

In 1967 the hoars of Sunamganj produced 100000 tonnes of fish, but In FY2014-15 this amount dramatically declined to 22692 tonnes (Khan, 2016). To increase the amount fish production in Bangladesh government should increase the amount of subsidies and facilities to marginal fish farmers,provide more training programs and new funding schemes to fish farmers, and should be concerned about climate changing factors which negatively affect the fish production and fish diversity. Finally, the government should increase government expenditure in the fisheries sector, implement more modern technologies to enhance the fish production and set up strong rules and legislations to stop Jatka (young hilsa) catching and others illegal fishing activities in Bangladesh.

7. CONCLUSION

The aim of this paper was to investigate the relationship between gross domestic product (GDP) and independent variables, namely, rice production, fisheries production in Bangladesh over the period of 1971 to 2017. Stationary of each time series was tested by augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test. The results of the tests provided that all the variables are non-stationary at the level, but after taking the first difference they become stationary. Applying Johansen

co integration test I found that the variables are co integrated and have long-run relationship between the dependent and independent variables. Results of FMOLS and DOLS indicated that rice production has a positive and significant impact on gross domestic product (GDP) of Bangladesh. On the other hand, although fisheries production has a positive impact on gross domestic product (GDP), it is not significant. Last but not the least, severalresidual diagnostics test results revealed that the model has no serial correlation and the residuals are normally distributed.

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APENDIX

Correlogram of residuals squared (FMOLS)

Autocorrelation	*Partial Correlation*		*AC*	*PAC*	*Q-Stat*	*Prob*
. |** |	. |** |	1	0.292	0.292	4.1717	0.041
. |*. |	. |. |	2	0.144	0.065	5.2153	0.074
. |. |	. |. |	3	0.003	-0.060	5.2159	0.157
. |*. |	. |*. |	4	0.103	0.119	5.7738	0.217
. |. |	. |. |	5	0.005	-0.052	5.7749	0.329
.*|. |	.*|. |	6	-0.076	-0.099	6.0967	0.412
.*|. |	.*|. |	7	-0.123	-0.068	6.9581	0.433
. |. |	. |. |	8	-0.044	0.016	7.0730	0.529
. |. |	. |. |	9	-0.006	0.019	7.0752	0.629
. |. |	. |. |	10	-0.021	-0.017	7.1020	0.716
. |. |	. |*. |	11	0.054	0.092	7.2861	0.775
. |. |	. |. |	12	0.004	-0.038	7.2871	0.838
.*|. |	.*|. |	13	-0.110	-0.159	8.0959	0.837
. |. |	. |. |	14	-0.055	0.022	8.3067	0.873
. |. |	. |. |	15	-0.048	-0.028	8.4724	0.903
.*|. |	.*|. |	16	-0.100	-0.106	9.2042	0.905
. |. |	. |. |	17	-0.054	0.049	9.4284	0.926
.*|. |	.*|. |	18	-0.106	-0.072	10.316	0.921
. |. |	. |. |	19	-0.019	0.005	10.346	0.944
. |. |	. |. |	20	0.034	0.052	10.444	0.959

Correlogram of residuals squared (DOLS)

Autocorrelation	*Partial Correlation*		*AC*	*PAC*	*Q-Stat*	*Prob*
. |** |	. |** |	1	0.275	0.275	3.5722	0.059
. |. |	.*|. |	2	-0.031	-0.116	3.6191	0.164
. |. |	. |. |	3	-0.051	-0.010	3.7456	0.290
. |. |	. |*. |	4	0.060	0.082	3.9283	0.416
. |. |	.*|. |	5	-0.042	-0.099	4.0190	0.547
. |. |	. |. |	6	-0.057	-0.010	4.1929	0.651
. |. |	. |. |	7	-0.060	-0.043	4.3897	0.734
. |. |	. |. |	8	-0.017	-0.006	4.4057	0.819
. |. |	. |. |	9	0.000	0.009	4.4057	0.883
. |. |	. |. |	10	-0.012	-0.022	4.4147	0.927
. |. |	. |. |	11	-0.062	-0.055	4.6509	0.947
. |. |	. |. |	12	-0.036	-0.008	4.7312	0.966
.*|. |	.*|. |	13	-0.146	-0.165	6.1318	0.941
.*|. |	. |. |	14	-0.111	-0.034	6.9610	0.936
.*|. |	.*|. |	15	-0.127	-0.112	8.0879	0.920
.*|. |	.*|. |	16	-0.193	-0.189	10.781	0.823
.*|. |	.*|. |	17	-0.176	-0.097	13.096	0.730
. |. |	. |. |	18	-0.041	-0.037	13.224	0.778
. |** |	. |** |	19	0.261	0.266	18.733	0.474
. |** |	. |*. |	20	0.223	0.082	22.923	0.293